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NOTICE OF RELEASE OF

NBR-1 GERMPLASM BASALT MILKVETCH

| **Douglas A Johnson, Thomas A Jones, Kevin J Connors, Kishor Bhattarai, B Shaun Bushman, and Kevin B Jensen**

ABSTRACT

A selected-class pre-variety germplasm of basalt milkvetch (*Astragalus filipes* Torr. ex A. Gray [Fabaceae]) has been released for reclamation, rehabilitation, and restoration of semiarid rangelands in the northern Great Basin Region of the western US.

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KEY WORDS

Astragalus filipes, Fabaceae

NOMENCLATURE

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COLLABORATORS

USDA Agricultural Research Service, Forage and Range Research Lab, Logan, Utah; Utah Agricultural Experiment Station, Utah State University, Logan, Utah

Photo by James H Cane

Species | *Astragalus filipes* Torr. ex A. Gray
Common Name | Basalt milkvetch
Plant Symbol | ASFI

NBR-1 Germplasm basalt milkvetch (*Astragalus filipes* Torr. ex A. Gray [Fabaceae]), a selected-class pre-variety germplasm, has been released for use in the northern Great Basin Region of the western US. Commercial seeds will be available in October 2009.

JUSTIFICATION

Arid and semiarid rangelands are usually nitrogen (N) limited, and only a few North American legumes are commercially available for restoring rangelands in the Intermountain Region of the western US. Legumes in rangelands fix atmospheric N in association with rhizobial bacteria, enhance plant diversity, and increase the quantity and quality of forage for livestock and wildlife. They may directly or indirectly increase the productivity of associated species in plant communities by releasing symbiotically fixed N through root exudates, decaying plant materials, or mycorrhizal hyphae networks (Rumbaugh and others 1982). Basalt milkvetch is one legume that is widely distributed in western North America (Isely 1998) and may be useful for rangeland revegetation and restoration applications in the western US. The widespread nature of basalt milkvetch lessens the potential concern that it could lead to novel hybridization with threatened *Astragalus* species (Caicco 2008). This species has not been reported to be toxic to livestock and wildlife, exhibits a flush of growth after fire, and may be competitive with the invasive annual downy brome (*Bromus tectorum* L. [Poaceae]). No germplasms or cultivars are commercially available for basalt milkvetch. Primary beneficiaries of this germplasm are expected to be land management agencies, ranchers, landowners enrolled in USDA conservation programs, and the seed industry.

COLLECTION INFORMATION

Seeds of 67 accessions were collected in 2003 from Utah, Idaho, Nevada, Oregon, Washington, and California. These sites ranged in elevation from 200 to 2662 m (656 to 8733 ft). Long-term mean annual precipitation at these sites ranges from 196 to 612 mm (8 to 24 in). Long-term mean annual minimum temperatures at these collection sites range from –5 to 4 °C (23 to 39 °F), and long-term mean annual maximum temperatures range from 10 to 19 °C (50 to 66 °F). Twenty of these 67 accessions came from the Northern Basin and Range Level III Ecoregion (Omernik 1987; US EPA 2007). From these 20 collection sites, 12 accessions from Utah, Idaho, Oregon, Nevada, and California were selected for inclusion in NBR-1 Germplasm (Table 1). Collection sites for these 12 accessions were dominated or previously dominated by communities of big sagebrush (*Artemisia tridentata* Nutt. [Asteraceae]) and juniper (*Juniperus* spp. [Cupressaceae]). The 12 collection sites ranged in elevation from 1234 to 1874 m (4049 to 6148 ft).

Collection sites for germplasm used in developing Basalt milkvetch. See county names and other location details in Table 1.

TABLE 1

Overall means for seed yield (g/plot) from Millville combined across 2 y (2005 and 2006) for basalt milkvetch accessions from the Northern Basin and Range Ecoregion (Omernik 1987). Constituent accessions of NBR-1 are bolded and were not statistically different ($LSD_{0.05}$ = 2.4 g/plot) in seed yield from the top-performing accession (Af-18) in the Northern Basin and Range Ecoregion.

Accession	State	County	Elevation (m)	N latitude	W longitude	Seed yield (g/plot)
Af-18	**OR**	**Lake**	**1463**	**42° 28′**	**119° 47′**	**3.4**
Af-8	**OR**	**Harney**	**1502**	**42° 56′**	**118° 36′**	**3.1**
Af-45.1	**ID**	**Owyhee**	**1234**	**43° 24′**	**116° 59′**	**3**
Af-13	**OR**	**Harney**	**1315**	**43° 04′**	**118° 46′**	**2.8**
Af-41	**NV**	**Elko**	**1774**	**41° 48′**	**115° 56′**	**2.4**
Af-42[z]	OR	Malheur	1250	43° 15′	117° 12′	1.8
Af-77[z]	OR	Malheur	1595	43° 26′	117° 55′	1.8
Af-19[y]	OR	Harney	1331	43° 26′	119° 00′	1.8
Af-9	**OR**	**Harney**	**1396**	**43° 07′**	**118° 16′**	**1.7**
Af-14	**OR**	**Harney**	**1449**	**42° 48′**	**118° 49′**	**1.7**
Af-15	**CA**	**Modoc**	**1410**	**41° 36′**	**120° 25′**	**1.4**
Af-44[z]	OR	Malheur	1446	43° 08′	117° 28′	1.2
Af-63	**OR**	**Lake**	**1501**	**42° 18′**	**120° 20′**	**1.2**
Af-45[y]	ID	Owyhee	1250	43° 26′	116° 58′	1.1
Af-16	**CA**	**Modoc**	**1530**	**41° 53′**	**120° 18′**	**1.1**
Af-20	**OR**	**Harney**	**1617**	**42° 56′**	**119° 54′**	**1**
Af-69	**UT**	**Box Elder**	**1874**	**41° 54′**	**113° 58′**	**1**
Af-3[x]	NV	Humboldt	1476	41° 52′	118° 35′	0.6
Af-66[x]	NV	Humboldt	2499	41° 41′	117° 34′	0.4
Af-43[x]	ID	Owyhee	1717	42° 17′	115° 56′	0.3

$LSD_{0.05}$ = 2.4

[z] Af-42, Af-77, and Af-44 were excluded from NBR-1 Germplasm because no residual seeds were available for these accessions.

[y] Af-19 was excluded from NBR-1 Germplasm because it had detectable levels of selenium, and Af-45 was not included because it had detectable levels of both nitrotoxin and swainsonine.

[x] Af-3, Af-66, and Af-43 were excluded from NBR-1 Germplasm because these accessions had statistically lower seed yields ($LSD_{0.05}$ = 2.4 g/plot) than did Af-18, the top accession for seed yield for the Northern Basin and Range Ecoregion.

DESCRIPTION

Basalt milkvetch is a perennial, North American legume that is native to California, Idaho, Nevada, Oregon, Utah, Washington, northern Mexico, and British Columbia, Canada (Isely 1998). Basalt milkvetch is typically tall, sparsely leafed, and has a thick, woody taproot with clustered, clump-forming, and erect stems. Plants have pale-yellow to creamy white flowers and a characteristic thread-like, stipitate pod attachment with laterally compressed, glabrous pods. Basalt milkvetch is a tetraploid ($2n = 24$) and occurs commonly on basalt-derived, sandy, loamy, or gravelly soils in sagebrush (*Artemisia* spp.) steppe, pinyon–juniper (*Pinus edulis* Engelm. [Pinaceae] and *Juniperus* spp.) woodlands, ponderosa pine forests (*Pinus ponderosa* P.& C. Lawson [Pinaceae]), or chaparral ecosystems (Barneby 1964; Isely 1998). It is one of the most abundant and widely dispersed *Astragalus* species within the following Level III Ecoregions (Omernik 1987; US EPA 2007): Northern Basin and Range, Central Basin and Range, Blue Mountains, and Columbia Plateau.

METHOD OF DEVELOPMENT

Seeds were collected from a minimum of 100 plants for the 67 accessions during July and August 2003. Seeds were cleaned and stored in a dark room maintained at 3 °C (37 °F) and 20 to 25% relative humidity until use. In June and July 2003, 6 aboveground stems with attached leaves were harvested at a 2-cm (0.8 in) stubble height from 10 individual plants at each of 67 field-collection sites. Wildland plants were harvested, dried, ground, and then analyzed for selenium, nitrotoxins, and swainsonine, as described by Bhattarai and others (forthcoming).

During January 2004, seeds were germinated on moistened blotter paper, transplanted to cone-shaped plastic containers in a greenhouse, and subsequently outplanted into field plots at 2 locations in northern Utah (Millville and Providence), as described by Bhattarai and others (forthcoming). The experimental design at both locations was a randomized complete block design with 6 replications. Plots consisted of 5 plants of an accession with 0.5-m (1.6-ft) spacing within and between rows.

After one year of establishment, plant height, number of stems, number of inflorescences, and plant vigor score (on a scale of 0 to 9) were determined for each plot at both sites in both years during late May to early June. At the Providence site, biomass was harvested at a 5-cm (0.8-in) stubble height at about 50% bloom during 24–27 June 2005 and on 7 June 2006. Regrowth biomass was also harvested at Providence on 17 October 2005 and 18 October 2006. At the Millville site, biomass was harvested on 2 August 2005 and 8 August 2006 (after mature seed was harvested), and regrowth biomass was harvested on 26 October 2005. Negligible regrowth occurred at the Millville site in 2006 so regrowth biomass was not harvested in 2006. Plant samples were oven-dried at 60 °C (140 °F) for 72 hr, and then sample dry weights were determined. Seed production was evaluated at the Millville site only. Because of differing plant maturation among accessions, seeds were sequentially harvested from mid-July to early August in both years after pods matured. Seed mass was determined from 100-seed samples.

Accessions differed significantly ($P < 0.01$) for all measured plant traits, except for crude protein concentration in both years. Plant traits differed between years, except for plant height and crude protein concentration at Providence and for plant height at Millville. The range of values for the measured plant traits was substantial. As a result, ample opportunities exist for improving basalt milkvetch through breeding and selection.

Of the 20 accessions from the Northern Basin and Range Ecoregion, none had detectable levels of swainsonine. Only accessions Af-43, Af-44, and Af-45 had detectable levels of nitrotoxins, ranging from 0.10 to 0.48 mg/g. In addition, both Af-19 and Af-45 had selenium concentrations of 1.4 µg/g. To minimize potential toxicity problems, all 4 accessions with detectable levels of nitrotoxins or selenium were excluded from NBR-1 Germplasm.

Three accessions (Af-3, Af-43, and Af-66) had statistically lower seed yields than the other accessions from the Northern Basin and Range Ecoregion (Table 1). Other accessions from the Northern Basin and Range Ecoregion were not statistically different from each other for seed yield. Because of low seed yields for Af-3, Af-43, and Af-66, these accessions were excluded from NBR-1 Germplasm. In addition, no residual seeds from the original collection sites were available for Af-42, Af-44, and Af-77 so these accessions were excluded from NBR-1 Germplasm. As a result, Af-8, Af-9, Af-13, Af-14, Af-15, Af-16, Af-18, Af-20, Af-41, Af-45.1, Af-63, and Af-69 were included as constituent accessions for NBR-1 Germplasm.

NBR-1 Germplasm is a manipulated-track plant material because not all original collections from the Northern Basin and Range Ecoregion were included as constituent accessions of NBR-1 Germplasm. Other than selection for seed yield and reduced nitrotoxin and selenium content, no further selection or manipulation was conducted.

ECOLOGICAL CONSIDERATIONS

Basalt milkvetch is a long-lived, perennial legume that initiates growth in the spring and reaches maturity by mid-July. It grows upright, and seeds of this species are relatively easy to harvest as compared with many low-growing *Astragalus* species. Seed predation by seed weevils (*Tychius* spp.) and seed beetles (*Acanthoscelides* spp.) limits the availability of viable seeds of basalt milkvetch on wildland sites (Youtie and Miller 1986). Application of imadicloprid insecticide enhanced seed yield in a common-garden study (Bhattarai and others forthcoming) and may be useful in commercial seed production.

This species is prominent in recently burned areas, making it a promising species for restoration and revegetation on western US rangelands. Its prevalence after fire may be especially important considering the increasing fire frequency on rangelands (Whisenant 1990) and considering the importance of fire as an ecosystem management tool in restoring rangeland ecosystem function. Although no reports of toxicity have been reported for basalt milkvetch, many species of *Astragalus* are toxic to livestock because of problems related to 3 main toxins: selenium, nitrotoxins (3-nitroproponal or 3-nitropropionic acid), and indolizidine alkaloids such as swainsonine (Kingsbury 1964; Williams and James 1975; James and Nielsen 1988).

Infective and effective rhizobial bacteria are essential for biological N fixation in any leguminous species. Failure to form root nodules with effective rhizobia on host legume plants impedes legume establishment in rangelands, and thus, makes non-nodulated legumes less desirable in revegetation programs (Gonzalez-Andres and Ortiz 1996). Greenhouse tests specific for 6 rhizobial strains isolated from root nodules of basalt milkvetch identified one rhizobial strain that consistently exhibited exceptional infectiveness and effectiveness for N fixation. Inoculant with this strain is commercially available from EMD Crop BioScience (13100 West Lisbon Avenue, Brookfield, WI 53005; 262.957.2000; mark.gentry@emdcrop bioscience.com).

ANTICIPATED CONSERVATION USE

NBR-1 Germplasm is intended for conservation uses that include post-fire reclamation, native range restoration, wildlife habitat improvement, plant diversity enhancement, and rehabilitation of disturbed areas. Because of the showy flowers and drought-resistant characteristics of basalt milkvetch, NBR-1 may also be of interest to gardeners and homeowners in xeriscaping applications in the Intermountain Region of the western US.

ANTICIPATED AREA OF ADAPTATION

NBR-1 Germplasm is intended for use in the restoration and rehabilitation of degraded and burned rangelands in the Northern Basin and Range Ecoregion, which includes northwestern Utah, northern Nevada, southern Idaho, southeastern Oregon, and northeastern California. Based on where the constituent accessions were collected, NBR-1 Germplasm will do well in basalt-derived, sandy, loamy, or gravelly soils in sagebrush steppe and pinyon–juniper woodlands (Barneby 1964; Isely 1998). This includes semiarid basins, benches, dissected lava plains, and mountain foothill areas characteristic of the Northern Basin and Range Ecoregion. The constituent accessions of NBR-1 Germplasm were collected in areas that ranged in elevation from 1234 to 1874 m (4049 to 6148 ft) and ranged in annual precipitation from about 200 to 450 mm (8 to 18 in).

AVAILABILITY OF PLANT MATERIALS

Seeds of Af-8, Af-9, Af-13, Af-14, Af-15, Af-16, Af-18, Af-20, Af-41, Af-45.1, Af-63, and Af-69 collected at their respective wildland sites were bulked by equal weights to form the G_0 generation of NBR-1 Germplasm. These seeds will be maintained by the USDA ARS Forage and Range Research Laboratory, Logan, Utah, and will be made available to commercial growers for distribution by the Utah Crop Improvement Association. (Stanford Young, Utah Crop Improvement Association, Plants, Soils and Climate Department, Utah State University, Logan, Utah 84322-4820; 435.797.2082; sayoung@ mendel.usu.edu.) Seeds through the G_5 generation will be eligible for certification.

Photo by James H Cane

Small quantities of seeds will be provided to researchers on request to the corresponding author (Douglas Johnson). Appropriate recognition should be made if this material contributes to the development of a new breeding line or cultivar.

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